

Module Examination Essential mathematics 1

Time allowed: 3 hours

This paper has **TWO** sections. You should attempt **ALL** questions in each section.

Section A carries 68% of the marks. It has 34 questions, each worth 2%.

Section B carries 32% of the marks. It has 8 questions, each worth 4%.

Each question is multiple-choice, with **ONE** correct answer from five options. No marks will be deducted for incorrectly answered questions.

Mark your answers on the computer-marked examination (CME) form provided, using an HB pencil. Instructions for filling in the CME form are given on the next page. The assignment number for this examination is **MST124 81**.

Write your rough work in the spaces provided in this question paper. You may also request an answer book for further rough work. Your rough work will not be considered by the examiners.

At the end of the examination

- Make sure that you have completed Part 1 of the CME form.
Failure to do so will mean that your work cannot be identified.
- Make sure that you have entered one answer (A, B, C, D or E) against each of questions 1–42 in Part 2 of the CME form.
- Place this question paper on top of any answer book(s) used, put your signed desk record on top and fix them all together using the fastener provided. Attach your CME form to the back of this pack using the flat paper clip provided.
It is important that the flat paper clip is used with the CME form since the computer cannot read CME forms with punched holes.

Instructions for filling in the computer-marked examination (CME) form

If you do not follow these instructions, the examiners may not be able to award you a score for the examination.

You will find one CME form provided with this paper. The invigilator has a supply of spare forms.

Writing on the form

- Use an HB pencil.
- To mark a cell, pencil across it, as demonstrated on the form.
- To cancel a mark, pencil in the coloured part of the cell, as demonstrated on the form.
- If you make any unwanted marks on the form that you cannot cancel clearly, then ask the invigilator for a new form, and transfer your entries to it.

Completing Part 1

- Write your personal identifier (NOT your examination number) and the assignment number for this examination, which is **MST124 81**, in the boxes provided.
- In the blocks headed 'PERSONAL IDENTIFIER' and 'MODULE AND ASSIGNMENT NUMBER', pencil across the cells corresponding to your personal identifier and the assignment number given above.
- On the sample CME form opposite, Part 1 has been completed for a fictitious student so that you can see how to complete this part of the form.

Completing Part 2

- For each question (numbered 1 to 42), mark your answer by pencilling across ONE of cells A, B, C, D or E.
- If you think that a question is unsound in any way, pencil across the 'unsound' cell (U), *as well as* pencilling across an answer cell.
- Do not pencil across any other cell.

Sample CME form

COMPUTER MARKED EXAMINATION FORM

08-10

PART 1

PERSONAL IDENTIFIER
(NOT Examination Number)

A7654321

ASSIGNMENT NUMBER
(as given on the question paper)

MST124 81

NAME and INITIALS

A. STUDENT

IMPORTANT NOTES

1. Please check that all of this form has been completed including the coloured boxes in Part 1 with your Personal Identifier, Module and Assignment Number.
2. Only use an HB pencil to complete this form and press firmly.
3. Shown opposite are examples of the correct marks to use. Do not use any other types of mark.

**PLEASE DO NOT PUNCH HOLES
IN THIS FORM**

Fold this form INWARDS along the dotted line

PERSONAL IDENTIFIER									
A	0	0	0	0	0	0	0	0	0
B	1	1	1	1	1	1	1	1	1
C	2	2	2	2	2	2	2	2	2
D	3	3	3	3	3	3	3	3	3
E	4	4	4	4	4	4	4	4	4
F	5	5	5	5	5	5	5	5	5
G	6	6	6	6	6	6	6	6	6
H	7	7	7	7	7	7	7	7	7
K	8	8	8	8	8	8	8	8	8
L	9	9	9	9	9	9	9	9	9
M									X
N									
P									
R									
S									
T									
U									
V									
W									
X									
Y									

CORRECT MARK

Pencil across
between dots



CANCELLATION MARK

To cancel a mark
pencil in the
coloured part of
the cell. Do not rub out

MODULE AND ASSIGNMENT NUMBER										OFFICE USE ONLY	
A	A	A	A	0	0	0	0	0	0	0	0
B	B	B	B	1	1	1	1	1	1	1	1
C	C	C	C	2	2	2	2	2	2	2	2
D	D	D	D	3	3	3	3	3	3	3	3
E	E	E	E	4	4	4	4	4	4	4	4
F	F	F	F	5	5	5	5	5	5	5	5
G	G	G	G	6	6	6	6	6	6	6	6
H	H	H	H	7	7	7	7	7	7	7	7
K	K	K	K	8	8	8	8	8	8	8	8
L	L	L	L	9	9	9	9	9	9	9	9
M	M	M	M								
N	N	N	N								
P	P	P	P								
R	R	R	R								
S	S	S	S								
T	T	T	T								
U	U	U	U								
W	W	W	W								
X	X	X	X								
Y	Y	Y	Y								
Z	Z	Z	Z								

OFFICE USE ONLY



The Open University

PART 2

ANSWER										ANSWER										ANSWER												
1	A	B	C	D	E	F	G	H	?	U	21	A	B	C	D	E	F	G	H	?	U	41	A	B	C	D	E	F	G	H	?	U
2	A	B	C	D	E	F	G	H	?	U	22	A	B	C	D	E	F	G	H	?	U	42	A	B	C	D	E	F	G	H	?	U
3	A	B	C	D	E	F	G	H	?	U	23	A	B	C	D	E	F	G	H	?	U	43	A	B	C	D	E	F	G	H	?	U
4	A	B	C	D	E	F	G	H	?	U	24	A	B	C	D	E	F	G	H	?	U	44	A	B	C	D	E	F	G	H	?	U
5	A	B	C	D	E	F	G	H	?	U	25	A	B	C	D	E	F	G	H	?	U	45	A	B	C	D	E	F	G	H	?	U
6	A	B	C	D	E	F	G	H	?	U	26	A	B	C	D	E	F	G	H	?	U	46	A	B	C	D	E	F	G	H	?	U
7	A	B	C	D	E	F	G	H	?	U	27	A	B	C	D	E	F	G	H	?	U	47	A	B	C	D	E	F	G	H	?	U
8	A	B	C	D	E	F	G	H	?	U	28	A	B	C	D	E	F	G	H	?	U	48	A	B	C	D	E	F	G	H	?	U
9	A	B	C	D	E	F	G	H	?	U	29	A	B	C	D	E	F	G	H	?	U	49	A	B	C	D	E	F	G	H	?	U
10	A	B	C	D	E	F	G	H	?	U	30	A	B	C	D	E	F	G	H	?	U	50	A	B	C	D	E	F	G	H	?	U
11	A	B	C	D	E	F	G	H	?	U	31	A	B	C	D	E	F	G	H	?	U	51	A	B	C	D	E	F	G	H	?	U
12	A	B	C	D	E	F	G	H	?	U	32	A	B	C	D	E	F	G	H	?	U	52	A	B	C	D	E	F	G	H	?	U
13	A	B	C	D	E	F	G	H	?	U	33	A	B	C	D	E	F	G	H	?	U	53	A	B	C	D	E	F	G	H	?	U
14	A	B	C	D	E	F	G	H	?	U	34	A	B	C	D	E	F	G	H	?	U	54	A	B	C	D	E	F	G	H	?	U
15	A	B	C	D	E	F	G	H	?	U	35	A	B	C	D	E	F	G	H	?	U	55	A	B	C	D	E	F	G	H	?	U
16	A	B	C	D	E	F	G	H	?	U	36	A	B	C	D	E	F	G	H	?	U	56	A	B	C	D	E	F	G	H	?	U
17	A	B	C	D	E	F	G	H	?	U	37	A	B	C	D	E	F	G	H	?	U	57	A	B	C	D	E	F	G	H	?	U
18	A	B	C	D	E	F	G	H	?	U	38	A	B	C	D	E	F	G	H	?	U	58	A	B	C	D	E	F	G	H	?	U
19	A	B	C	D	E	F	G	H	?	U	39	A	B	C	D	E	F	G	H	?	U	59	A	B	C	D	E	F	G	H	?	U
20	A	B	C	D	E	F	G	H	?	U	40	A	B	C	D	E	F	G	H	?	U	60	A	B	C	D	E	F	G	H	?	U

Section A

You should attempt **ALL** questions in this section. Each question is worth 2%.

Question 1

Which of the following is equivalent to $3(2x + 1) + (3 + x)(x - 2)$?

- A** $x^2 + 9x + 1$ **B** $x^2 + 7x - 5$ **C** $x^2 + 7x - 3$ **D** $x^2 + 11x + 9$
E $11x + 9$

Question 2

What is the solution of the equation $\frac{2}{x} = \frac{3}{2x} + \frac{5}{3}$?

- A** $\frac{3}{10}$ **B** $\frac{2}{5}$ **C** $\frac{3}{5}$ **D** $\frac{3}{2}$ **E** $\frac{5}{3}$

Question 3

Which of the following is equivalent to $a^{-1}b^2\sqrt[3]{a^2b^5}$, where $a > 0$ and $b > 0$?

- A** $a^2b^{19/2}$ **B** $a^2b^{9/2}$ **C** a^5b^{17} **D** $\frac{b^{7/3}}{a^{1/3}}$ **E** $\frac{b^{11/3}}{a^{1/3}}$

Question 4

If $y = \sqrt{\frac{2x+z}{x}}$, which of the following is equal to x ?

- A** $\frac{z}{y^2 - 2}$ **B** $\frac{3+z}{y^2}$ **C** $\frac{z}{y^2 - 2y\sqrt{2} - 2}$
D $\frac{\sqrt{3+z}}{y}$ **E** $\frac{z}{y - \sqrt{2}}$

Question 5

What is the gradient of the straight line passing through the points $(5, 2)$ and $(7, -3)$?

- A** $-\frac{5}{2}$ **B** $-\frac{1}{2}$ **C** $-\frac{2}{5}$ **D** $\frac{2}{5}$ **E** $\frac{5}{2}$

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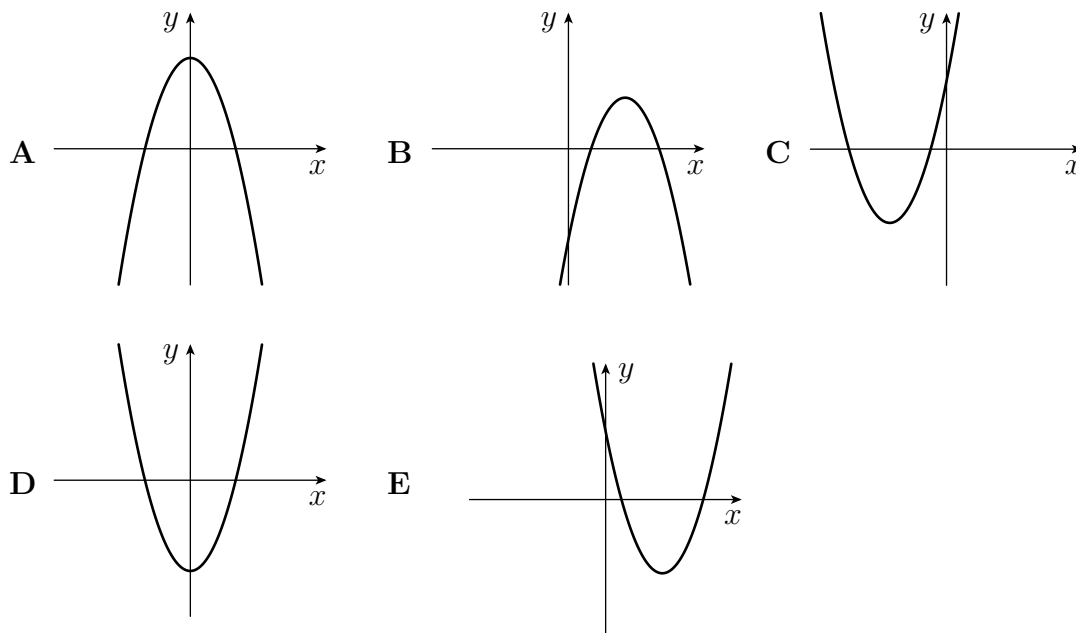
Question 6

When the quadratic expression $3x^2 - 12x + 5$ is written in the completed-square form $a(x + r)^2 + s$, what is the value of s ?

- A** -31 **B** -7 **C** -3 **D** 3 **E** 7

Question 7

Which of the following could be the graph of the equation $y = x^2 + 4x + 3$?

**Question 8**

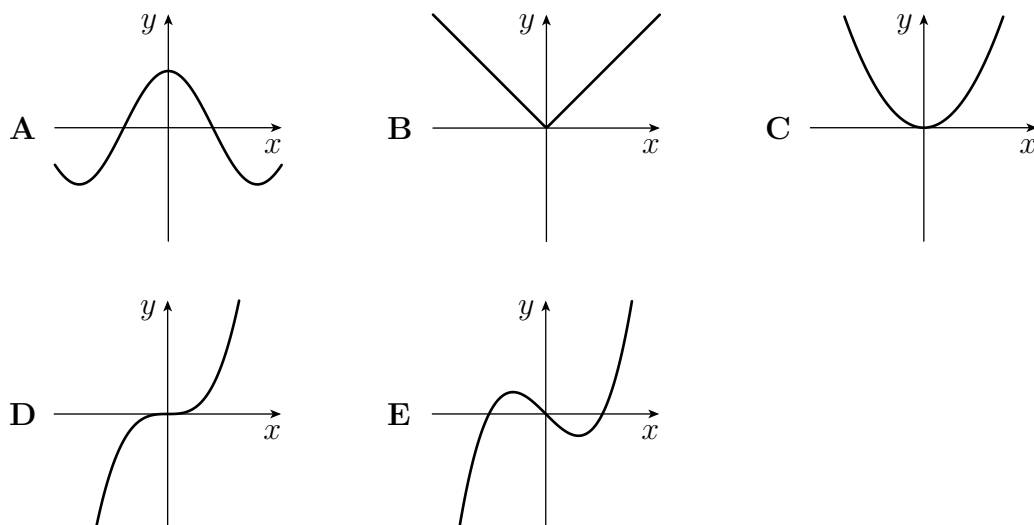
What is the x -intercept of the line with equation $3x + 4y = 6$?

- A** -2 **B** $-\frac{1}{2}$ **C** $\frac{1}{2}$ **D** 2 **E** 6

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Question 9

Which of the following is the graph of a one-to-one function?



Question 10

If $f(x) = \sqrt{x}$ and $g(x) = x^2 + 2$, what is the rule of the function $g \circ f$?

- A $(g \circ f)(x) = \sqrt{x^2 + 2}$ B $(g \circ f)(x) = x^2\sqrt{x} + 2\sqrt{x}$
C $(g \circ f)(x) = x + 2$ D $(g \circ f)(x) = x + \sqrt{2}$
E $(g \circ f)(x) = x^{3/2} + 2x^{-1/2}$

Question 11

What is the rule of the inverse function of $f(x) = 5x + 2$?

- A $f^{-1}(x) = \frac{x-2}{5}$ B $f^{-1}(x) = \frac{1}{5x+2}$ C $f^{-1}(x) = \frac{5}{x-2}$
D $f^{-1}(x) = x - \frac{2}{5}$ E $f^{-1}(x) = \frac{x}{5} - 2$

Question 12

Which of the following is equivalent to $\ln(x^2e^{4y})$?

- A $8y \ln x$ B $(x+2y) \ln 2$ C $2 \ln(x+2y)$ D $2 \ln x + 4y$
E $2 \ln x + 4 \ln y$

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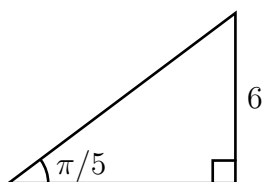
Question 13

Which of the following is the solution set of the inequality $x^2 \leq 12 + x$?

- A** $(-\infty, -3] \cup [4, \infty)$ **B** $[-3, 4]$ **C** $[-4, 3]$
D $(-\infty, -4] \cup [3, \infty)$ **E** $\emptyset$

Question 14

The right-angled triangle below (which is not drawn to scale) has an angle of $\pi/5$ radians. The side opposite this angle has length 6.

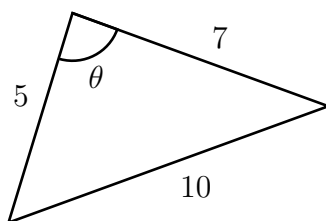


What is the length, to one decimal place, of the hypotenuse?

- A** 3.5 **B** 6.4 **C** 7.4 **D** 10.2 **E** 12.3

Question 15

The triangle below (which is not drawn to scale) has sides of lengths 5, 7 and 10.



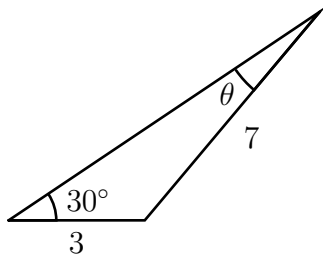
What is the size, to the nearest degree, of the angle θ opposite the side of length 10 ?

- A** 22° **B** 68° **C** 92° **D** 112° **E** 158°

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Question 16

The triangle below (which is not drawn to scale) has sides of lengths 3 and 7. The angle opposite the side of length 7 is 30° .



What is the size, to the nearest degree, of the angle θ opposite the side of length 3 ?

- A** 12° **B** 20° **C** 78° **D** 59° **E** 138°

Question 17

How many values of θ in radians between $-\pi/2$ and 2π satisfy $\cos \theta = 0.3$?

- A** 0 **B** 1 **C** 2 **D** 3 **E** 4

Question 18

Which of the following equations represents the circle with centre $(3, -2)$ and radius 4 ?

- A** $x^2 + y^2 - 4x + 6y - 3 = 0$ **B** $x^2 + y^2 - 6x + 4y - 3 = 0$
C $x^2 + y^2 - 6x + 4y = 16$ **D** $x^2 + y^2 - 4x + 6y = 16$
E $x^2 - y^2 - 6x - 4y - 3 = 0$

Question 19

What is the component form of the vector with magnitude 4 that makes an angle of 120° with the positive x -direction?

- A** $2\sqrt{3}\mathbf{i} - 2\mathbf{j}$ **B** $2\mathbf{i} - 2\sqrt{3}\mathbf{j}$ **C** $2\mathbf{i} + 2\sqrt{3}\mathbf{j}$ **D** $-2\sqrt{3}\mathbf{i} + 2\mathbf{j}$
E $-2\mathbf{i} + 2\sqrt{3}\mathbf{j}$

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Question 20

Which of the following is the derivative of $f(x) = \frac{1}{2x^{2/3}}$?

- A** $f'(x) = -\frac{4}{3x^{5/3}}$ **B** $f'(x) = -\frac{1}{3x^{5/3}}$ **C** $f'(x) = \frac{x^{5/3}}{3}$
D $f'(x) = \frac{3x^{1/3}}{4}$ **E** $f'(x) = \frac{3x^{1/3}}{2}$

Question 21

Which of the following is the derivative of $g(x) = 10x^4 - 3x^2 + 8$?

- A** $g'(x) = 2x^5 - x^3 + 4x^2$ **B** $g'(x) = 10x^3 - 3x$
C $g'(x) = 40x^4 - 6x^2 + 8$ **D** $g'(x) = 40x^3 - 6x$
E $g'(x) = 40x^3 - 6x + 8$

Question 22

Which of the following is the derivative of $p(x) = x^3 \ln x$?

- A** $p'(x) = 3x$ **B** $p'(x) = 3x^2 \ln x$ **C** $p'(x) = 3x^2 \ln x - x^2$
D $p'(x) = 3x^3 + x^2 \ln x$ **E** $p'(x) = 3x^2 \ln x + x^2$

Question 23

Which of the following is the derivative of $r(t) = \tan(t^2 - 2t)$?

- A** $r'(t) = \sec^2(t^2 - 2t)$ **B** $r'(t) = 2t \sec^2(t^2 - 2t)$
C $r'(t) = 2(t - 1) \sec^2(t^2 - 2t)$ **D** $r'(t) = \sec^2(t^2 - 2t) + 2t - 2$
E $r'(t) = \sec^2(t^2 - 2t) + 2(t - 1) \tan(t^2 + 2t)$

Question 24

Which of the following is equal to $\int (x^{3/2} + 2 \sin x) \, dx$?

- A** $\frac{2}{5}x^{5/2} + 2 \cos x + c$ **B** $\frac{2}{5}x^{5/2} - 2 \cos x + c$ **C** $\frac{5}{2}x^{5/2} + 2 \cos x + c$
D $\frac{5}{2}x^{5/2} - 2 \cos x + c$ **E** $\frac{3}{2}x^{5/2} + 2 \cos x + c$

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Question 25

For a certain function f , it is known that $\int_2^5 f(x) \, dx = 4$ and $\int_2^3 f(x) \, dx = -2$.

What is $\int_3^5 f(x) \, dx$?

- A** -6 **B** -2 **C** 2 **D** 3 **E** 6

Question 26

What is the area between the graph of $y = x + \sin x$ and the x -axis, from $x = 0$ to $x = \pi/2$?

- A** $\frac{\pi^2}{8} - 1$ **B** $\frac{\pi^2}{8}$ **C** $\frac{\pi^2}{8} + 1$ **D** $\frac{\pi^2}{4} - 1$ **E** $\frac{\pi^2}{4} + 1$

Question 27

Which of the following is equal to $\int e^{4x-1} \, dx$?

- A** $e^{2x^2-x} + c$ **B** $4e^{4x-1} + c$ **C** $\frac{1}{4}e^{4x-1} + c$ **D** $\frac{e^{4x-1}}{4x} + c$
E $e^{4x-1} + 4x + c$

Question 28

If $\mathbf{P} = \begin{pmatrix} 4 & 2 \\ 1 & 6 \end{pmatrix}$ and $\mathbf{Q} = \begin{pmatrix} 3 & 1 \\ 1 & 0 \end{pmatrix}$, what is $3\mathbf{P} - 2\mathbf{Q}$?

- A** $\begin{pmatrix} 9 & 5 \\ 2 & 18 \end{pmatrix}$ **B** $\begin{pmatrix} 6 & 4 \\ 1 & 18 \end{pmatrix}$ **C** $\begin{pmatrix} 18 & 8 \\ 5 & 18 \end{pmatrix}$ **D** $\begin{pmatrix} 12 & -2 \\ 3 & 0 \end{pmatrix}$
E $\begin{pmatrix} 6 & 5 \\ 2 & 18 \end{pmatrix}$

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Question 29

If $\mathbf{R} = \begin{pmatrix} 3 & 2 & 1 \\ 0 & 1 & 3 \\ 4 & 2 & 0 \end{pmatrix}$ and $\mathbf{S} = \begin{pmatrix} 1 & 4 & 2 \\ 2 & 0 & 1 \\ 0 & 3 & 2 \end{pmatrix}$, what is $\mathbf{RS}$?

- A** $\begin{pmatrix} 11 & 10 & 13 \\ 10 & 6 & 2 \\ 8 & 7 & 9 \end{pmatrix}$
B $\begin{pmatrix} 3 & 8 & 2 \\ 0 & 0 & 3 \\ 0 & 6 & 0 \end{pmatrix}$
C $\begin{pmatrix} 4 & 6 & 3 \\ 2 & 1 & 4 \\ 4 & 5 & 2 \end{pmatrix}$
D $\begin{pmatrix} 3 & 4 & 1 \\ 0 & 0 & 3 \\ 4 & 3 & 0 \end{pmatrix}$
- E** $\begin{pmatrix} 7 & 15 & 10 \\ 2 & 9 & 7 \\ 8 & 16 & 10 \end{pmatrix}$

Question 30

What is the determinant of the matrix $\begin{pmatrix} 2 & -3 \\ 4 & -5 \end{pmatrix}$?

- A** -22 **B** -2 **C** 2 **D** 14 **E** 22

Question 31

Which of the following is an alternative specification of the sequence specified by the recurrence system

$$x_1 = 10, \quad x_n = \frac{1}{4}x_{n-1} \quad (n = 2, 3, 4, \dots) \quad ?$$

- A** $x_n = 10 \left(\frac{1}{4}\right)^n \quad (n = 1, 2, 3, \dots)$
B $x_n = 10 \left(\frac{1}{4}\right)^n \quad (n = 2, 3, 4, \dots)$
- C** $x_n = 10 \left(\frac{1}{4}\right)^{n-1} \quad (n = 1, 2, 3, \dots)$
D $x_n = 10 \left(\frac{1}{4}\right)^{n-1} \quad (n = 2, 3, 4, \dots)$
- E** $x_n = 10 \left(\frac{1}{4}\right)^{n+1} \quad (n = 1, 2, 3, \dots)$

Question 32

Which of the following is true for the sequence (a_n) given by

$$a_n = -\frac{1}{5} \times 2^n \quad (n = 1, 2, 3, \dots) \quad ?$$

- A** (a_n) is bounded **B** (a_n) is increasing **C** (a_n) converges to a limit
- D** $a_n \rightarrow \infty$ as $n \rightarrow \infty$ **E** $a_n \rightarrow -\infty$ as $n \rightarrow \infty$

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Question 33

Which of the following is equal to the complex number $\frac{2+6i}{1-i}$?

- A** $-2+4i$ **B** $2-4i$ **C** $2-6i$ **D** $2+6i$ **E** $8+4i$

Question 34

What is the principal argument of the complex number $-4-4\sqrt{3}i$?

- A** $-\frac{4\pi}{3}$ **B** $-\frac{2\pi}{3}$ **C** $\frac{\pi}{3}$ **D** $\frac{2\pi}{3}$ **E** $\frac{4\pi}{3}$

TURN OVER FOR SECTION B

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Section B

You should attempt **ALL** questions in this section. Each question is worth 4%.

Question 35

Which of the following is the x -coordinate of a point where the line $y = 2x + 1$ intersects the circle $x^2 + y^2 - 2x - 6y - 10 = 0$?

- A** $x = \frac{1}{5}$ **B** $x = 1$ **C** $x = 2$ **D** $x = 3$ **E** $x = \frac{11}{3}$

Question 36

The function f has derivative $f'(x) = 7(x + 5)(x - 3)^2$. What are the natures of its stationary points?

- A** $x = -5$ is a local minimum and $x = 3$ is a local maximum
B $x = -5$ is a local minimum and $x = 3$ is a horizontal point of inflection
C $x = -5$ is a local maximum and $x = 3$ is a local minimum
D $x = -5$ is a local maximum and $x = 3$ is a horizontal point of inflection
E $x = -5$ is a horizontal point of inflection and $x = 3$ is a local minimum

Question 37

What is the derivative of $\sin((2 - 3x)^2)$?

- A** $-6 \cos(2 - 3x) \sin(2 - 3x)$ **B** $-6(2 - 3x) \cos((2 - 3x)^2)$
C $-3 \cos((2 - 3x)^2)$ **D** $3(2 - 3x) \cos((2 - 3x)^2)$
E $3 \cos(2 - 3x) \sin(2 - 3x)$

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Question 38

The velocity v (in metres per second) of an object in terms of time t (in seconds) is given by the equation $v = 1 - 6t^2$. The displacement of the object at time $t = 0$ is 10 m. What is its displacement at time $t = 4$?

- A** -599 m **B** -178 m **C** -134 m **D** -114 m **E** -38 m

Question 39

Which of the following is equal to $\int_0^{\pi/9} \sin(3x) \cos^2(3x) \, dx$?

- A** $-\frac{1}{8}$ **B** $-\frac{7}{72}$ **C** $\frac{7}{72}$ **D** $\frac{1}{8}$ **E** $\frac{7}{24}$

Question 40

Which of the following is equal to $\int (3x + 1)e^{2x} \, dx$?

- A** $\frac{1}{4}e^{2x}(6x - 1) + c$ **B** $\frac{1}{4}e^{2x}(6x + 5) + c$ **C** $\frac{1}{2}e^{2x}(3x - 1) + c$
D $\frac{1}{2}e^{2x}(3x + 2) + c$ **E** $(3x - 2)e^{2x} + c$

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Question 41

What is the coefficient of t^{-5} in the expansion of $\left(2t + \frac{1}{t^2}\right)^{10}$?

- A** 0 **B** 3360 **C** 8064 **D** 11520 **E** 13440

Question 42

What is the Cartesian form of the complex number $\left(\frac{1}{2} - \frac{1}{2}i\right)^{-7}$?

- A** $-4 - 4i$ **B** $4 - 4i$ **C** $-8 + 8i$ **D** $8 - 8i$ **E** $-16 + 16i$

[END OF QUESTION PAPER]

[THIS PAGE IS LEFT BLANK FOR ROUGH WORK]

